Automated Monitoring

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Abstract
Procedures are introduced to automatically update a website for land use sustainability monitoring each time the inventory base data is updated. The Automated Monitoring Protocol provides a systematic approach to unbiased, comprehensive and timely reports on natural resources sustainability. The protocol consists of three procedures:

1. Workshops to capture the relationship between resource data and monitoring reports.
2. Detailed data flow logic documentation.
3. An automation tool for public access to relevant information.

A pilot project in the Bulkley Land and Resource Management Plan area provides a 37-page biodiversity monitoring report accessible with an internet compliant Visual Basic program. Improved website capability and other LRMP values are under development.

The approach of scripted data modelling and evaluation of plan values has wide application in any value set where inventories are periodically updated. Automated monitoring ensures comparable results over time for trend analysis. This website tool presents the integration and access of spatial data and non-spatial data using ArcIMS and therefore resultant PDF documents, images, tabular results and the ability to generate current results via the internet are available in a user-friendly and effective manner. Our efforts to reach sustainability are now available for the world to see.

Introduction
Much has been said and written about planning, criteria/indicators and monitoring. A measured, objective, unbiased, and simple approach is needed to bring all the loose ends together for the public of British Columbia. This paper proposes such an approach using scientific expertise, current systems analysis discipline for documentation and Web-based computers. A working example, the Bulkley Monitoring Model Project (BMMP), is provided.

The demand for environmental monitoring information is high but the supply is low (Brown 2001)[1]. At the same time, more data are being gathered for research and resource management through automatic data loggers, new resource inventories and updates of existing inventories. Tying the information supply with the demand requires a new paradigm: one that has been introduced to us as a computer virus. These insidious subroutines manipulate our computers and data to their own purposes. The same paradigm is now applied to inventory update processes but this time with the data owners' agreement and with a useful output. Automated monitoring is beneficial viruses providing information to an easily accessible public interface.

Maintaining public confidence in resource stewardship is required despite changes in the principles of resource stewardship responsibility, reductions in public service staff and budget cuts in government. The Automated Monitoring Protocol (AMP) connects three activities in a logical sequence to instil public confidence, as resource owners, that plans for sustainability are implemented and values respected. As the public becomes more aware of our ultimate dependence on the environment, they need timely and accurate information within the appropriate context.

Monitoring helps us understand the complexity of the ecosphere. It supplies the information needed for adapting resource management activities to the changing condition of the environment. AMP seeks to reduce uncertainty by ensuring the multi-megahertz computer capacity to manipulate complex data consistently and in a timely manner, fits within the decision cycle required of resource managers. The ecosphere's ability to sustain productivity and biodiversity of ecosystems (and thereby to sustain society with its demands for services and resources from the ecosphere) is dependent on complex interactions among various species within the ecosystem and between the ecosystem and the surrounding geophysical world[2]. A monitoring system must handle these complexities.

LRMPs and sub regional land use plans are the first consensus value set to balance the complexity of social, economic and environmental concerns at the local level and define sustainability for a specific geographic area. These defined balances are the foundation of sustainability. With demands on the environment clearly stated in terms of specific targets,

supply (and the rate of consumption) can be tracked. A scientific approach is used first to capture the most appropriate indicators of sustainability, then to document the logic of data flow from field data to final tables/graphs for the report, and finally to script this logic into computer programs.

Who will be involved in this system? First, data suppliers who update environmental information will be involved. An agreement with data suppliers in industry, the government and other agencies will have to be forged. A team of experts will be needed not only to identify indicators but also to maintain the system. AMP means anyone (i.e. forest managers, decision makers, the public, ENGOs, or forest resource customers) can track environmental changes over the Internet. AMP reduces costs of periodic monitoring by reducing the human input requirements in recursive monitoring reports.

AMP concepts were piloted in the Bulkley Monitoring Model Project (BMMP). Sustainable biodiversity as defined by the Bulkley Land and Resource Use Plan (LRMP) is monitored using a Web-based automation tool. A 37 page monitoring report of maps, charts, graph, tables and text is available on the Web with a Visual Basic (VB) program developed for limited distribution. This proof-of-concept pilot stores a copy of the biodiversity indicators on the Skeena Information Management (SIM) Group, Skeena Region, MSRM, URL for update. The VB program calls up the latest biodiversity indicators on this URL and brings in the biodiversity indicators for display.

The word "protocol" is defined as "the rules, formalities, etc of any procedure…" (Oxford 1991). The "Protocol" in AMP was selected because a number of different rules, disciplines, and procedures are being followed to reach the ultimate goal of public access to sustainability monitoring.

The Protocol

How do we tell if lands and resources are managed sustainably? Land use plans are complex and exacting. Resource data are not only complex and exacting but also comprehensive, ever changing and voluminous. Indicators of sustainability must be organized in a simple yet comprehensive monitoring report. Timely information and widely available results add to the challenge of providing a "good" monitoring report. To satisfy all these needs, a set of interlocking procedures called a protocol has been devised.

The core of this approach is agreement among multi-disciplined scientific experts on how data are processed. The conceptual model in Figure 1 shows the relationship between two main activities: creating indicators, and evaluating those indicators against plan targets. The data flow from raw data to indicators is called the data model and resides on the data supplier's site. The indicators are made available for transfer via the Internet to the values model which resides on the same Web site as the plan. The values model evaluates indicators relative to the planned targets and displays/changes graphs, maps and tables accordingly.

History

Fortunately, an example of a second generation monitoring report exists. The Lakes Forest District reached consensus on the use of low volume undesirable forests and a systematic method of reporting the harvesting in these forests.

A monitoring plan for volume class profiles clearly stated the background and intent of the consensus in the Lakes District timber use plan, yet it failed to supply sufficient direction to ensure consistent reporting over a period of only two years. Consensus was reached among timber users in the Lakes Forest District in 1986 to harvest low volume forests in proportion to natural occurrence. Licensees would not harvest the highest economic value first, but would harvest all stands in proportion to their occurrence within each licensee's chart area. To determine the natural occurrence, all harvestable forests were placed into one of four classes according to the current volume of the stand. These volume class profiles were tracked. The depletion of the natural stands was monitored using satellite imagery to determine their harvest volume class profile. The results were then compared as percentages in the monitoring report. The key graphs from the first monitoring report follow:

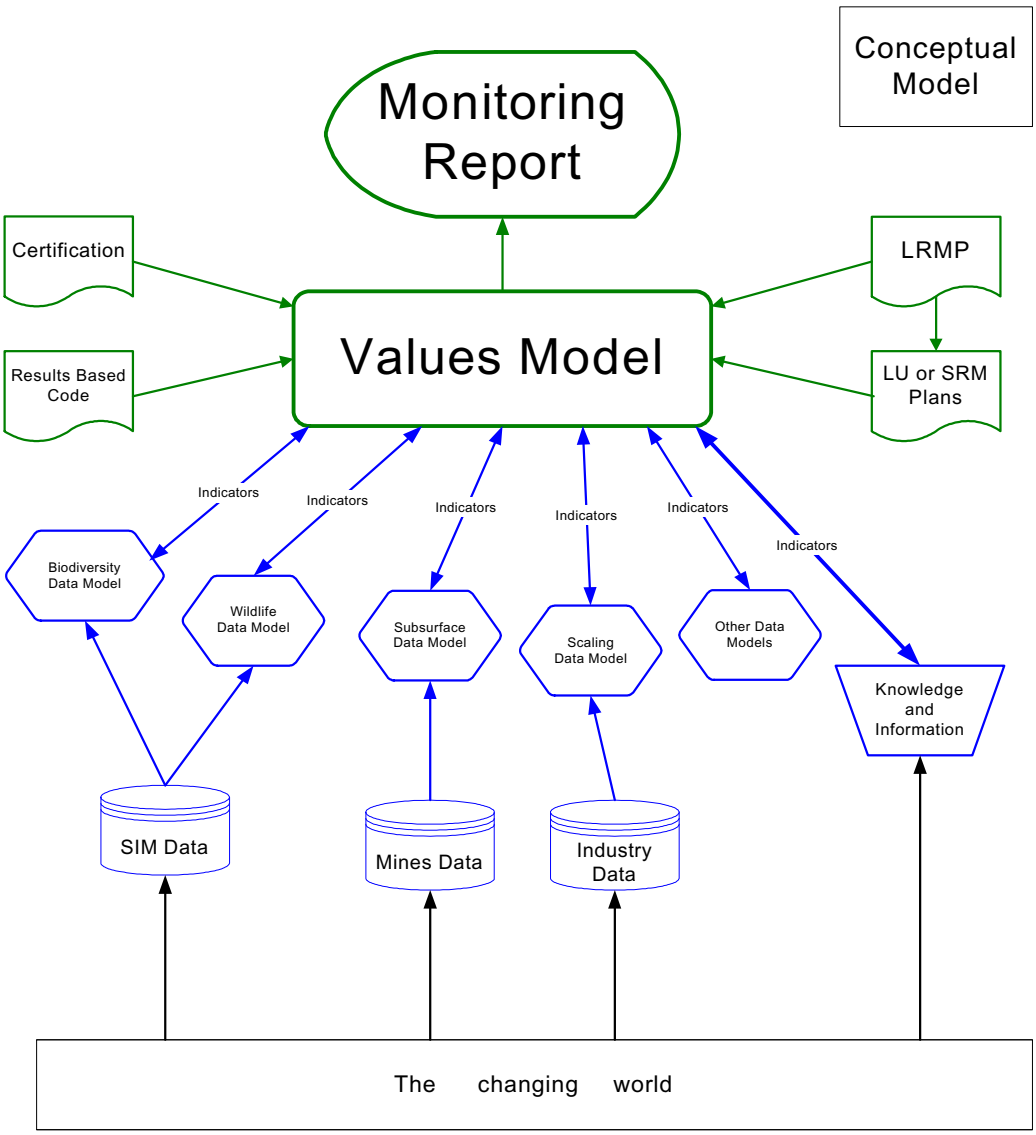
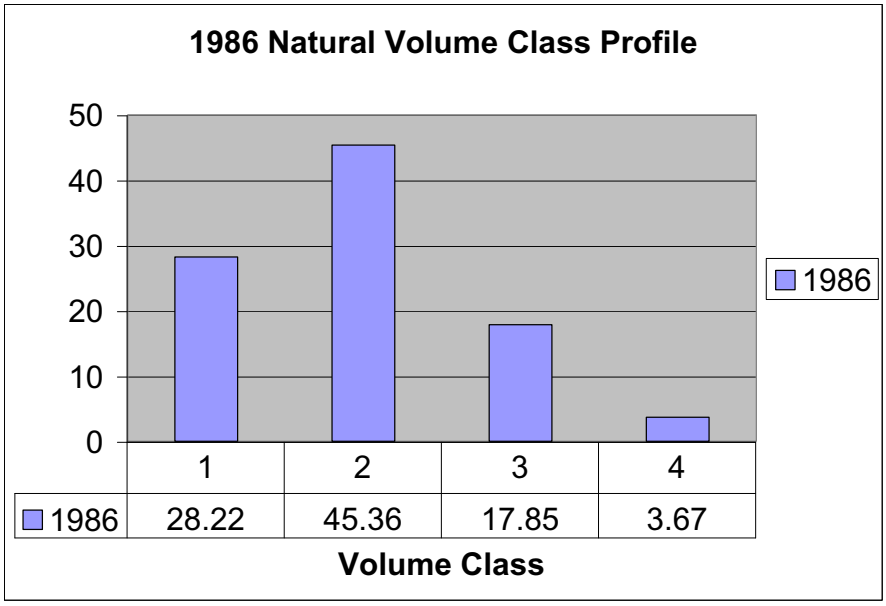
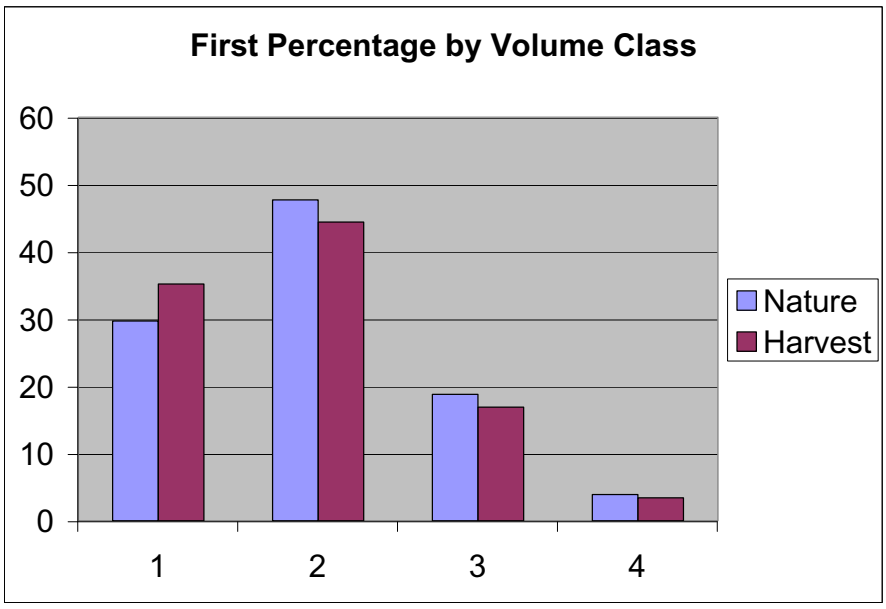


Figure 1. Conceptual Model of Automated Monitoring

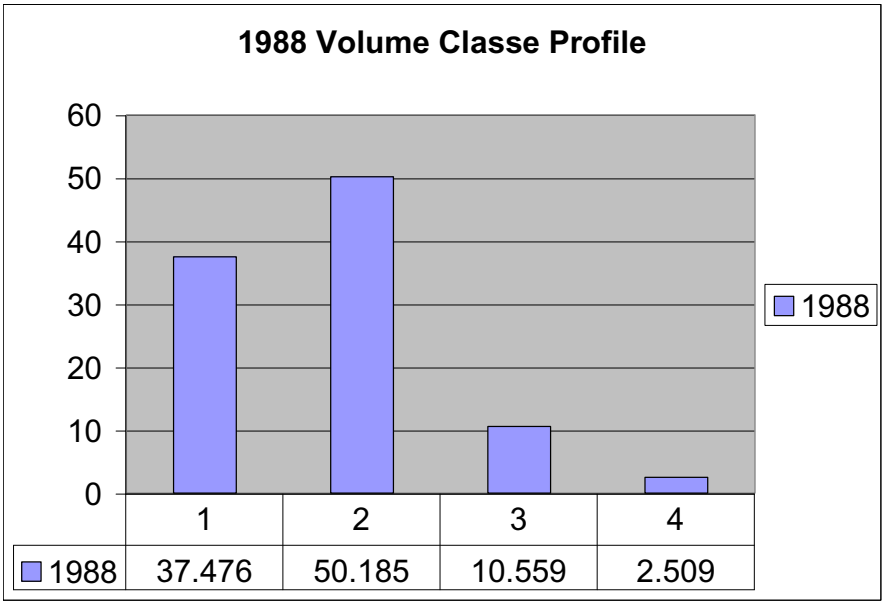


Total Volume is 95,100,000 cu M

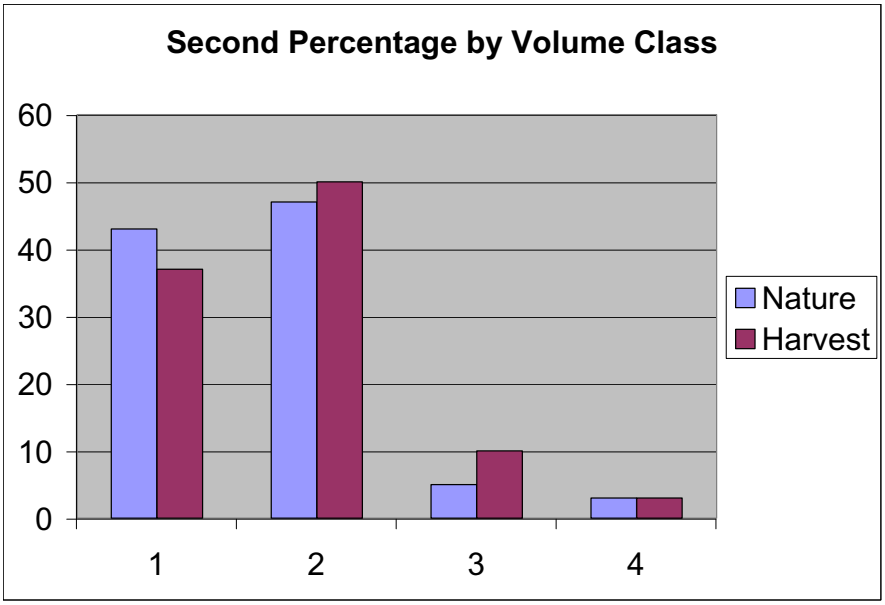


The message in the monitoring report was that the harvesting in the most valuable volume class (1) did not meet the target in the consensus.

The same monitoring plan was used for the second iteration yet it turned out to be very different. The key graphs from the second monitoring report follow:



Total volume is 100,729,000 cu. M.



The message in the second monitoring report should have been that the target consensus on the most valuable class (1) had been met. But consider the differences in the total volume between the 1986 and 1988 natural volume class profiles. The volume increase in the two years (by about 5,000,000 cubic metres) could not be explained. Without a valid explanation, the results could not be published. The differences could not be tracked because a systems analysis approach was not used. Despite determined effort and considerable expense, the monitoring reports could not be compared for trend analysis. Greater discipline is needed at the beginning if monitoring results are to be comparable over time. This discipline is supplied with systems analysis techniques.

A good resource use plan and even a monitoring plan do not save the public and resource manager from data problems with recursive measurements for monitoring. A more scientific and detailed approach using systems analysis techniques is needed.

Principles

The AMP was developed using the following principles:

(1) Conform to Government Direction.

The New Era Commitment (a pre-election statement of intent by the BC Liberal party) states the government will:

- *Adopt a scientifically based, principled approach to environmental management that ensures sustainability, accountability and responsibility;*
- *Utilizes "integrated information that can be accessed by users both within and outside government."*

Automated monitoring requires experts to develop the most appropriate indicators of environmental values. They agree on the best way for data to flow from updates to a monitoring report. Automating the process ensures consistency and provides an information base for comparison of time series measurements. Integrated information is accessible by users both within and outside government as described in the Internet section of this report.

(2) In Harmony with Ministry Principles

Stan Hagen, Minister of Sustainable Resource Management, stated in his 2002-05 Service Plan that the "ministry is committed to the following principles: Science-based decision-making [i.e.] Using the best available knowledge and technology to support consistent decision-making….." Scientists chosen for their expertise select the best indicators from the best available knowledge. Their logic is leveraged using the latest technology in AMP to provide decision-makers with a solid foundation for decisions. AMP is also in harmony with the practices of the Ministry. Reduced budgets and staffing levels mean that staff struggles to perform the work most effectively. By setting up scripts to automatically sort, summarize and evaluate, information the repetitive work required for monitoring is reduced or eliminated.

(3) Stewardship

Sustainability can only be fully understood on a global scale, yet this scale presents almost insurmountable obstacles for measurement. "Given that structure and function, be they ecological, social or economic interact across a wide range of different spatial (and equally temporal) scales in unequal fashion, selecting any subset scale e.g., a nation or a forest, for monitoring or assessment will result in an artificially and incomplete bounded area."(Beasley et al, 2001[3]). Strategic land use plans provide the perspective needed to understand sustainability and stewardship. A key purpose of AMP is to present information from the known perspective of a plan, and allow the public to determine stewardship quality.

(4) Unbiased

Indicator workshops bring together the experts in data content and handling, in sustainability indicators and in values articulation to create data flow logic that bridges the gap between inventories and final monitoring reports. Experts are no longer restrained by what is available in a single database. The Internet can connect databases in different locations so data are not excluded from consideration just because they are not in the Ministry of Sustainable Resources data set. Experts are free to determine the best data available, then set up data flow logic to capture the data.

(5) Accessible

All databases can be accessed through the Internet if data sets are kept small. Some more remote data suppliers may have only 56K modems so an Internet connection is slow. AMP utilizes the amazing speed of the average desktop computer to manipulate the data model, while designing for slow Internet service by concentrating information in indicators. Accessibility also means public access. Government Web sites are available to an ENGO in Germany or USA lumber marketing firm, as well as to BC residents.

(6) Comprehensive

The data models can be designed to manage any data type. All data, even from the most remote part of the province, can be considered as long as the data exists. Manual and automatic systems are envisioned in AMP. Satellites may provide information on activities, water monitoring systems may automatically radio in readings, government personnel may enter compliance data from hand held field computers and large computers may define complex Predictive Ecosystem Maps, each contributing to the monitoring report.

(7) Timely

Because the script for handling updated data is part of the update process, the indicators are immediately posted to a file available over the Internet. Therefore the feedback to the resource manager is timely. It is in step with the decision time-frames needed for land use decision-making. Over several updates, the periodic information will form the basis of trend analysis and therefore help the manager to adapt her management to real time problems. Currently, delays in information processing after the inventory update can frustrate resource managers because they are forced to make decisions without appropriate feedback.

(8) Values Specific
Plans, policies and certification requirements are examples of statements of value. Value sets are important because they provide the perspective for monitoring. Perspective is the filter that helps chose the correct indicators and hence the correct source of data from the plethora of data available.

(9) Practical
AMP works with what is available. It is designed to use existing data, accepted indicators (that can be supported by that data) and a value set for a specific geographic area. The experts in each of the three disciplines are expected to solve the problems inherent in scale changes, data vagaries, statistical estimations, and data generalization. The indicators workshop has deadlines and is production oriented. Data flow diagrams and mock-ups of the monitoring report are designed for clear understanding of complex relationships and logic.

(10) Consistent
Consistency in handling complex data is important to evaluate trends. Documenting the data flow logic with data flow diagrams (DFD) provides current and future programmers with direction. The future is uncertain, yet the DFD provides certainty if data, indicators or values change. DFDs provide the basis for tracking and quantifying that change. Trend analysis is important in determining effectiveness of indicators and planned actions. See the History section (Page) for an example of the need for consistency.

(11) Partnerships
The long-standing partnership between industry and the public as owners of the resource is being changed. More reliance is being placed on the judgement of licensed professionals hired by industry. This increase in responsibility should be balanced with better reporting of results to the public. AMP restores the balance in this partnership. One update of field inventories provided information for both partners: the professional for adapting her management, and the public for assessing stewardship.

(12) Transparency
The impact on sustainability of an activity happening on public land should be available for public review. This principle goes to the heart of openness that fosters the trust necessary for the use of a public resource by the private sector. The owners should be able to understand the context of results created by a professional decision. AMP documents provide data flow logic, foster open discussion and provide the transparency needed in the new "results-based" world of BC forests.

(13) Expert Workshops
Well-qualified scientists are the best persons to provide the logic necessary for monitoring. Having experts in a workshop setting fosters constructive dialogue and a synergy of critical thinking. Individual scientists can theorize on the best indicators but it is in the workshop environment where they must face the practicalities of finding appropriate data and satisfying the need to display monitoring results. The best solutions to balancing the needs of practicality, expedience and scientific rigour can be found in a collaborative workshop.

(14) Minimize Duplication
The business of monitoring is about tracking changes, not duplicating databases. Capturing change to show its impact on sustainability is at the centre of AMP. A starting database is processed in accordance with the data flow logic to produce baseline metrics for indicators. At each update, only the changes are captured as output from the data model. Placing these changes in the appropriate context relative to the plan is the purpose of the values model in AMP.

(15) Maximize Technology
New standards for high-speed computers and extensive Internet connectivity provide a unique new advantage to be exploited. Speeds of two billion instructions per second are common in servers or desktop computers. To make best use of this computer speed, script are written to process large data sets in an intelligent, scientific manner that concentrates information into indicators. Internet service, even if slow, connects almost every forest industry database. Transmission of information concentrated in indicators is feasible even on limited bandwidth connections.

Protocol Methods

The three components of the protocol are: indicator workshops which include an agreement reached by experts, data flow logic which includes documenting the agreement and scripting it into computer programs and Internet connectivity which includes both data transfer and Web site design of monitoring reports.

The core of this approach is an agreement on how data are processed. An overview of the concepts for data processing can be found in Figure 1. It is made up of two components: a data model and a values model. The data model is resource issue specific and bridges the gap between the raw inventories and the indicators. Under normal conditions the data model would have inventories as the input and measures for indicators as the output. The values model provides an environment for evaluation of indicators against the targets outlined in a plan. The second model is envisioned to be closely tied to the geographic area and the targets outlined for the LRMP. Values models have indicator measures as input and the monitoring report as output. Agreement on the flow of information through these two models provides the foundation for the rest of the protocol.

Each of the three components of the protocol are discussed below.

Indicator Workshops

An indicator workshop is a one-day gathering of people who specialize in specific aspects of the planning and implementing process. An agreement is made among scientific experts in the disciplines important to monitoring: data acquisition, indicators of sustainability, values articulated in plans, and reporting of monitored results. Scientists agree on the most logical flow of data from field collection to monitoring report.

In a chain of reasoning, the plan determines what information is important to monitor, the monitoring needs drive the selection of indicators, and the indicators determine which raw data are selected for processing. But is the data flow logic realistic? Each indicator is then tested against data availability and the plan rationale to determine its worth in the monitoring report. Only the best indicators appropriately supported with data appear in the monitoring report.

The workshop should be a brainstorming session that brings together experts who understand the characteristics of a good indicator with those informed about available data and experts who understand the value set: i.e. the LRMP monitoring needs. Emphasis is to be placed on practical considerations such as: Is the value reported required by the LRMP? Is the indicator the most effective for the LRMP values statement and the data available? Is the data available to support this indicator?

As the workshop proceeds, the facilitator moves through a series of systematic phases:

- Brainstorming all potential indicators
- Bring out the “best” indicators from different perspectives.
- If the list of indicators is long, examine each indicator with the objective of reducing the number through combining and clarifying.
- Discuss stakeholder expectations for information, the look of the final monitoring report and the connection to the values expressed in the plan is held. This discussion may assist with clarifying the priority and further reducing indicators.
- Discuss the practicality of supplying data for each indicator. This may bring reality and immediacy to the supplying of information for indicators. A through understanding of the meta data associated with data sources is essential at this stage.

The final output is the logic of the data flow from raw inventories through indicators to presentation of knowledge the monitoring report.

The indicator meeting should have only the staff experts necessary to get to consensus data flow logic. An emphasis is placed on consensus building but at the detriment of efficiency and progress. Follow-up on the meeting includes documenting the data flow logic in data flow diagrams, re-stating the data requirements and building monitoring report mock-ups.

How do you define an expert? Who should be invited to an indicators workshop? The process is collaborative yet the facilitator must use his/her judgement to chose participants based on their familiarity with local conditions and scientific knowledge. Ability of experts to function in a group may also be considered when choosing data experts, indicator experts, values experts or monitoring experts.

The data experts have a good understanding of all the available data relevant to the plan area for the specific resource being monitored. So, for example, if the resource to be monitored were biodiversity the data experts would know what data are available in the monitored area and the full meaning of all data. Metadata (i.e. data about data) will be familiar to these experts.

The volume of information about indicators from various criteria and indicators publications now requires special research. Indicators have been described by the following publications:

1. Canadian Council of Forest Ministers (CCFM) "Defining Sustainable Forest Management" http://www.nrcan.gc.ca/cfs/proj/ppiab/ci/framain_e.html.
2. Montreal process Criteria and Indicators: http://www.mpci.org .
3. Prescott-Allen, Robert "A Digest of Indicators of Sustainable Forest Management" e-mail: rpa@wellbeing-of-nations.ca .
4. Daryl Brown, & John Dick; "Environmental Monitoring: Business and Information Needs Study" prepared for the ??:and Information and Inventory Coordinating Committee, Province of British Columbia. Internal document.
5. International Tropical Timber Organization, (ITTO) "Manual for the Application of Criteria and Indicators for Sustainable Management of Natural Tropical Forests.
6. Barbara Beasly, & Pamela Wright; "Criteria & Indicators Briefing Paper" Background Report fort the North Coast LRMP.
7. Ontario "State of the Forest Report 2001" found at http://www.mnr.gov.on.ca/MNR/forests/forestdoc/sofr/index.html.
8. Kamloops LRMP Monitoring Report 1999. A component of British Columbia's Land Use Strategy.

Expertise in the meaning and implications of indicators are necessary for the meeting. The best experts for indicators know how indicators have been developed for their discipline and can suggest the most efficient measures.

People involved in the planning process (or familiar with certification for example) will know the expectations of the stakeholders receiving the monitoring report. Knowing the value set intimately is important to understand the subtleties of presentation of information and knowledge. Values experts would typically have worked on the planning process and understand the stakeholders perspective on a particular resource. Values experts could be members of the public, government officials or industry spokespersons.

The facilitator is often required to be the expert in monitoring. This discipline is dependent on the type and media being used for distribution of the monitoring report.

The purpose of the workshop is to develop a set of verifiable, consistent and reliable monitoring procedures using data flow diagrams to document the processing of social, economic and environmental data from existing inventories through indicators to LRMP monitoring results. The products from the indicators workshop are a mock-up of the monitoring report, rough diagrams of data flow and specific statement on data requirements. The type of discipline required for an indicators workshop is very different then that required for the next step, which is to develop information systems.

Data Flow Logic

The primary purpose of the data flow diagrams is to document the flow of data from raw inventories to the final production of a monitoring report. The logic is grouped into two models: a data model and a values model.

The *data model* contains logic that changes raw inventory data to information on measures of indicators for storage on an URL. Data are processed into information for several reasons:

- The complexity and exactness of only a small part of an inventory may be needed for monitoring purposes and the other data causes confusion. These data are best left in the data warehouse.
- Different types of data are stored in different data warehouses. For example data for timber monitoring could come from forest valuation, which is stored in the Ministry of Forests Harvest Data Billing System (HDBS) or from forest cover which is stored in Data Service Centre in the Skeena Region. Data on subsurface resources is stored in a different location from tourism data.
- Each data type has its own discipline/standards and may require special protocols for access.
- Data dictionaries are often needed to ensure understanding of data standards.

The exact route for data during processing is logical to data experts for a specific data type. Separate data models are required for each data type. The logic of data-to-information flow from raw inventory to indicators is captured in data flow diagrams in the data model.

The *values model* is built from the values expressed in a plan. For example an LRMP has a series of strategies to achieve land use goals. Each of these strategies could be seen as an expression of the balancing of competing resource opportunities or as a statement of the relative value of each resource. Values may be expressed as desirable future conditions or as targets. Creating relevant, realistic and measurable targets is often the most difficult task the experts in the indicators workshop must perform. Vague statements of values provide an opportunity for experts to be creative

in determining how the value will be monitored but also provide the greatest opportunity for error. The creation of measurable indicators for each value drives the data flow process.

Each plan requires a different values model but a single values model receives indicators from many data models (see Figure 1: conceptual diagram). Measures of indicators go into the values model, monitoring reports come out of the values model

The data flow diagrams attempt to find the middle ground between broad conceptual representation and the extreme details of a programming language. Data flow diagrams should be written to provide guidance to any programmer scripting in any language: i.e. just enough information to consistently provide the logic but not so much as to force the use of a specific scripting language. In theory future programmers should have no trouble interpreting the logic and creating the same data flow with any scripting language.

Internet Access

For AMP the Internet has two functions: (1) to allow communication between the data models and the values model and (2) to distribute the completed monitoring report.

Logic produced by experts at the indicators workshop will point to various databases for the best data. These databases may be at different locations. Different locations are not a problem as long as the data model can be linked to the values model through the Internet. This will require development of partnerships with potential data providers. Development of data models at a number of different locations closest to the update location reduces the time for the monitoring cycle. Linking the models through the Internet provides easy and automated information transfer. At the same time the access to data in inventories that are neither necessary nor desirable could be controlled.

Several data models may be accessed to satisfy the needs of a plan. In other words partnerships with industry or other organizations may be necessary to satisfy the needs of a land use plan. The Internet could provide the connection between various suppliers of data as well as public interested in monitoring results.

Global access to an interactive Internet Web site distributes the monitoring results according to the interests of the client. Measures of indicators will be evaluated against the targets stated in the plan. Summaries of these measures, graphs of relationships of the information to sustainability and interactive maps that allow client specified access are envisioned. Both the planning targets (LRMP documents) and monitoring results will appear on the same site for easy reference between the plan and its outcome.

There are several types of users for this site, with each type of user having different expectations from the site. These users may be the general public, interest groups, government, and data administrators. The following are some functional highlights:

- Link spatial data with associated portions of plan text document.
- Provide document search functionality.
- Adhere to a consistent layout from plan to plan.
- Provide full-featured pan/zoom and identify mapping features.
- Provide specific structured queries for plan information.
- Ability to update plan status and log information, through password protected interface.
- Ability to view plan status and log information.
- Download arc/info RMZ coverages and associated data.

Wide access to monitoring information is a New Era goal. AMP uses “integrated information that can be accessed by users both within and outside government.” Integration of information occurs in the values model. The distribution of this information occurs over the Internet.

A Ministry of Sustainable Resource Management (MSRM) value is “accountability to the people of British Columbia”. AMP would demonstrate this commitment with appropriate monitoring information on environmental sustainability on the Internet. Automated monitoring would keep plans relevant by showing results in the context of an approved plan.

Certification

In general terms, forest certification may be defined as the examination of forests to see if they are being managed according to specified standards. The idea was to create a system by which forest products could be labelled in order to inform consumers of the management practices of the forest from which the wood originated. The theory is that, by giving consumers an informed choice, a market could be created for forest products from well–managed forests. Forest certification is not only a theoretical concept. It is very real and rapidly gaining in importance both with respect to trade and forest management practices. The standards by which "well-managed" is determined come from several sources:

1. Forest Stewardship Council.
2. ISO 14001.
3. Canadian Standards Association.
4. Sustainable Forestry Initiative.
5. Finnish Forest Certification System.
6. United Kingdom Woodland Assurance Scheme.
7. Pan–European Forest Certification.
8. The Keurhout Foundation and other systems[4].

With this proliferation of reporting standards, forest products companies are faced with a difficult decision: chose a single monitoring standard and sell only into that market or face the increased costs of producing paper monitoring reports to several standards and sell into several markets. The AMP can treat each certification standard as a separate set of values. Yet large portions of the data flow logic would, no doubt, be reusable in any certification system and only those portions that needed special logic would require extra work. Therefore the time and effort required for scripting a new certification standard would be minimized and could be matched with the extra benefit of create the new monitoring report. Several standards could be monitored simultaneously. Various standards could be placed on the Internet to service different customer needs depending on market considerations.

Future Applications

In the future AMP may provide a look-ahead system for changes in plans or development of scenarios. Since all targets would be integrated and the data processing consistent, a scenario or theoretical desired future states could be displayed as if the future already existed. By changing base data to some anticipated future state then running it through the data flow logic, and evaluating it against plan targets, one could determine if the intent of the plan would be achieved with the scenario. Scripting data flow logic into fast and powerful computers may have many uses currently unforeseen.

Conclusions

Automated monitoring could change the way the public view the forests. The Automated Monitoring Protocol is a natural progression of the use of scientific expertise and powerful computer systems to satisfy the complex and changing needs of people and the environment. Professional resource managers could have a responsive feedback mechanism that would reduce uncertainty around the impact of their decisions on sustainability. The public could monitor sustainability at a level of detail appropriate to their curiosity. Customers could satisfy their need for sustainability information about forest products purchased. In other words, the automated monitoring protocol could provide an information environment that rivals the depth, extent and complexity of the real environment.

The AMP project has the following advantages:

- It is based on new and innovative work that provides an exceptional advance over existing procedures and practices. Yet it is a logical step because it brings together capacities available from new technology recently developed in other fields.
- It targets critical areas of uncertainty that will clearly lead to significantly higher levels of confidence and credibility of resource management decisions.
- It is likely to develop significant, leading edge knowledge, skills or tools that will clearly contribute to more effective policies, regulations and/or guidelines for policy makers, decision makers and resource practitioners. The proposal demonstrates how these will serve as the basis for innovative policies and improved standards

Our Internet address for monitoring could be printed on each piece of lumber or forest product as part of the existing Council of Forest Industries (COFI) stamp. This would provide global access for our forest products customers to information on our efforts towards sustainability. The amount of complex information required by a person is dependent on their interest in the subject. The Internet-address-on-forest-products system could satisfy this need with wide distribution of the best possible information. Open and accessible information of the quality and value anticipated in the automated monitoring protocol may silence many of our critics.

We live in a global village.

It is time we use a global approach to communicating our actions, both planning and monitoring, to sustain the environment of British Columbia.

References

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[2] Karl-Henrik Robert The Natural Step story, 2002, New Society Publishers, pg 243

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[4] Forest Management Practices in Canada as an International Trade Issue, Report of the Standing Committee on Natural Resources and [Canadian] Government Operations Joseph Volpe, M.P., Chairman June 2000

APPENDIX 1 Glossary

Automated Monitoring Protocol (AMP): a sequence of procedures that ties updating of inventories through computers to updating of monitoring information on a Web site.

Bulkley Monitoring Model Project (BMMP): the first BC example of the use of automation to monitor a land use plan.

Data flow diagrams: a flowchart developed to show how data are changed, processed and manipulated from raw inventory through indicators to monitoring reports.

Data flow logic: the reasoning expressed by the combined work of the experts for data to be changed, processed and manipulated as it moves from inventory to monitoring report.

Data model: the group of relationships that determines the metrics of indicators from measurements in the inventory; a series of computer programs that reside on the information suppliers computer to process inventory data into a file of important facts to be stored on the URL and passed to the values model.

Land and Resource Management Plan (LRMP): a consensus land use plan that balances social, economic and environmental concerns for a defined geographic area.

New Era Commitments: statements made by the BC Liberal Party before they were elected in the 2001 provincial election.
Available at http://www.bcliberals.com/files/bcliberals_platform.pdf

Results Based: an administrative concept of checking results of activities not the procedures to achieve results. Usually refers to the administrative system for legislation such as the Forest and Range Practices Act.

Script: computer languages that processes, manipulate or evaluates data and information. These languages include AML, Oracle and ArcIMS among others.

Trends: recursive measurements of an indicator over time; the comparison of the results of measurement procedures for an inventory attribute over time.

Values Model: the script or group of computer programs that evaluate the indicators against the targets in the value set; the second AMP model that compares the measured results against the values in the land use plan and creates a monitoring report.

Values Set: the land and resource use plan; the values expressed by any coherent extensive group of statements that imply a desired future state for a specified land base.